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FACSIMILE TRANSMISSION

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[820504-1010]

TO	***FROM***
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For: Method for Species and Exchange and an Apparatus Therefore
Confirmation No.: 9713
Applicant: DuBose et al.

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on March 29, 2004.

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In Re Application of:

DuBose et al.

Serial No.: 09/975,870

Filed: October 12, 2001

Group Art Unit: 1724

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Docket No.: 820504-1010

For: **Method for Species and Exchange and an Apparatus Therefore**

The following is a list of documents enclosed:

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Further, the Commissioner is authorized to charge Deposit Account No. 20-0778 for any additional fees required. The Commissioner is requested to credit any excess fee paid to Deposit Account No. 20-0778.

AMENDMENTS TO THE SPECIFICATION

Please amend the specification as indicated hereafter. It is believed that the following amendments and additions add no new matter to the present application.

In the Specification:

Please amend the paragraph starting on p. 5, line 3 as follows:

The transfer device can be designed for single-pass or multiple-pass flow paths. A single-pass device accepts a flow from one side of the unit, and exhausts that flow on the [[5]] other side of the unit, wherein the flow makes a single-pass through the exchange media. A multiple-pass device, for example a double-pass device, enables the flow to traverse the wheel twice before being exhausted. In this double-pass embodiment, the length of the wheel can be half that used in relation to the length of the wheel in the single-pass device, but the wheel would be larger in diameter than the single-pass wheel. In an alternative embodiment of [[10]] the double-pass device, the flow may traverse the length of the housing assembly twice, but only encounter media in one trip (length) through the device. In this alternative double-pass embodiment, the length of the wheel can be equal to that used in relation to the length of the wheel in the single-pass device, but the wheel would be smaller in diameter than the double-pass wheel that has media in both passes.

Please amend the paragraph starting on p. 6, line 20 as follows:

Fig. 4 is a cross-sectional perspective view of an exemplary exchange media.[[.]]

Please amend the paragraph starting on p. 8, line 23 as follows:

Beyond fuel cell systems, other environments for the present species transfer device [[an]] <u>can</u> include HVAC systems wherein the device is a heat exchanger, or a chemical process where various gases and liquids may be removed, concentrated or transformed.

Please amend the paragraph starting on p. 11, line 1 as follows:

^{7}/°C to about 10 x 10^{-7}/°C, most preferred from about 3 x 10^{-7}/°C to about 8 x 10^{-7}/°C, optionally having an added sorbent, preferably a desiccant. Exemplary substances having low CTEs include cordierite and cordierite containing substances. In one embodiment of the present invention, the heat wheel is formulated to have a CTE low enough to prevent or reduce the wheel from changing shape, preferably by less than about 0.001 inches in any direction in response to changes in temperature such that the inlet and exhaust streams do not commingle. The species transfer device having such [[an]] a heat wheel optionally includes a sealing system.

Please amend the paragraph starting on p. 11, line 9 as follows:

Cordierite is a crystalline magnesium aluminum silicate having an average linear coefficient of thermal expansion reported to be in the range of 12 to 16 x 10^{-7}/°C. It has relatively high refractoriness and a melting point of about 1460°C. Cordierite has been used in cookware, dinnerware, and in catalytic converters of automobiles. U.S. Pat. No. 4,298,059 discloses the use of cordierite in a recuperative heat exchanger. U.S. Pat. No. 4,967,726 discloses a heat wheel made of cordierite used in [[a]] heating and ventilation systems for buildings. U.S. Pat. No. 6,183,895 discloses the use of cordierite as a carrier for a metal in a reforming catalyst used in a fuel cell power generating system. U.S. Pat. No. 5,702,508 discloses the use of cordierite as a ceramic rotor used to dry gases.

Please amend the paragraphs starting on p. 12, line 9 as follows:

Sealing system **45** of Fig. **3** provides a diametrical seal between the two flow paths **20** and **30**. Sealing system **45** can comprise a contact seal **108**. Contact seal **108** can be made of low friction material. Suitable low friction materials include but are not limited to Teflon™ or Peek™. In one embodiment, seal **108** is in direct contact with the end of media **80** and is maintained there by constant pressure exerted by an arrangement of springs **109** acting between the housing end ~~**43and**~~ **43 and** the seal plate **108**. The variable space between the seal plate **108** and the housing end ~~**43can**~~ **43** can be sealed, preferably by a congruent gasket, more preferably by a silicon gasket, that allows axial movement of the seal plate **108** while preventing flow between the seal plate **108** and the end of the housing **43** This slight axial movement allows for thermal expansion of the assembly and for wear of the sealing surfaces.

In other embodiments, the exchange media **80** comprises channels connecting first and second axial faces, a core, and a rim. Alternatively, the media wheel **80** may be a solid cylinder of media, without <u>a</u> core. The wheel **80** includes a plurality of parallel channels, which can generally be in the form of a hexagon in cross section, among other geometries. In one preferred embodiment, the channels are rectangular, more preferably square. The walls of the channels have a minimum thickness to inhibit the effect of the wall thickness increasing the pressure drop through the wheel **80** and yet provide the wheel **80** with sufficient structural integrity to be self supporting. The channels can be sized such that a distance between and along longitudinal axes of adjacent channels is generally uniform. Thus, the channels of the media **80**, due to their hexagonal cross-sectional configuration, are closely adjoined to increase the available transfer surface per unit of volume. The use of channels having a cross section that is generally in the form of a hexagon is advantageous over other geometries, such as sinusoidal, square, and triangular as the hexagon shape provides a greater available transfer surface area (i.e., based upon standard measurements and calculations of the geometries after coating of the interactive material) than the transfer surface area of a sinusoidal, triangle or square for a given volume. Further, the pressure drop through a media formed of hexagonal channels is significantly less than media constructed of the other geometries because there is virtually no buildup in the corners of the generally hexagon shaped channels; hence, the power necessary to force the flow through the media is less than that of the other geometries.

Please amend the paragraph starting on p. 13, line 6 as follows:

Generally, the larger the surface area of the exchange media, the more efficient the exchange media. Suitable surface areas of an exchange media are about 2000 – 5000 meters^2/meters^3 with appropriately sized channels. It will be appreciated that the exchange media can have more or less surface area depending on the desired efficiency of the ~~medim~~ <u>media</u>. Although in a preferred embodiment, the hexagonal flow channels extend axially through the entire length of the wheel **80**, in the direction of first and second stream flow, the size and orientation of the channels can vary according to need, but must be sufficiently small to maximize the total surface area for species transfer, yet sufficiently large relative to their length to minimize resistance to the stream flow.

Please amend the paragraph starting on p. 14, line 2 as follows:

In still ~~other~~ another embodiment, the exchange media **80** can be optionally coated with a sorbent, which according to a heat wheel embodiment, can be a water selective molecular sieve or desiccant. Exemplary desiccants include but are not limited to silica gel, activated alumina, gamma alumina, titanium silicate, glycols, calcium chloride, lithium chloride or other hydrophilic materials. In one embodiment, the desiccant-coated exchange media provides surface area for moisture transfer. A sorbent is herein defined as a substance that has the ability to take up and hold species, as by absorption or adsorption. The sorbent is chosen for its particular characteristics vis-à-vis the species to be transferred. If the species transfer device is used to transfer latent heat between streams, the sorbent can be a desiccant. If the species is CO, then the sorbent is a substance that can collect and release CO between the streams.

Please amend the paragraph starting on p. 14, line 20 as follows:

The suitable sorbents can include zeolites. Zeolites are highly crystalline alumino-silicate frameworks comprising $[SiO_4]^{4-}$ and $[AlO_4]^{5-}$ tetrahedral units. T atoms (Si, Al) are joined by [[an]] oxygen bridges. Introduction of an overall negative surface charge requires counter ions e.g. Na^+, K^+ and Ca^{2+}. The zeolite crystals contain water, and as the water is driven off by heating, there is no discernible collapse of the framework structure. This leads to a highly crystalline, microporous adsorbent that has an internal structure which can be easily tailored to adsorb any number of species.

Please amend the paragraph starting on p. 14, line 27 as follows:

Zeolites have beneficial molecular sieving properties. The pore size distribution can be modified, enabling the zeolite to be used as a so-called molecular sieve. Molecules which are too large to diffuse into the pores are excluded, whereas molecules which have a kinetic diameter smaller than the pore size, diffuse into the pores, adsorb and under certain conditions are capable of undergoing catalytic reactions. An example of this is in the sieving of straight and branched ~~chained~~ chain hydrocarbons to increase the octane number of gasoline.

Please amend the paragraph starting on p. 16, line 2 as follows:

A labyrinth seal can alternatively be used with a heat wheel **80** as shown in Fig. **6** wherein a rotary valve **162** is in radial form. The radial seal **164** divides the heat wheel **80** into two sides, with wedges **166** on the left separated from the wedges **168** on the right. The spokes **172** hold pressure, and wiping seals **174** keep the streams from intermixing. In this embodiment of the species transfer device **10**, the inlets **24, 34** of the housing enclosure **42** direct the first and second entering streams **20, 30** into the rotary valve **162.** By rotating the housing **40**, the first and second streams flow axially through the alternating media wedges **166** and **168.** [[.]]

Please amend the paragraph starting on p. 20, line 17 as follows:

The optional desiccant of the sensible and latent heat transfer device is capable of removing moisture from the cathode reactant exhaust stream, which removal releases heat and raises the exhaust stream temperature, which in turn heats the media of the enthalpy wheel. This same heat is used to power the release phase in the cathode reactant inlet stream upon rotation of the enthalpy wheel. A desiccant material naturally interacts with moisture from gases and liquids. The material becomes saturated as moisture [[is]] interacts with the desiccant; but when exposed to a dryer stream, the desiccant releases moisture - or regenerates - and can be used again. The enthalpy wheel of the present invention can include solid desiccants, for example, silica gel, activated alumina, gamma alumina, lithium chloride salt, and molecular sieves. Titanium silicate, a class of material called 1m, and synthetic polymers are newer solid desiccant materials designed to be more effective for cooling applications. Alternatively, the enthalpy wheel can include liquid desiccants, for example, lithium chloride, lithium bromide, calcium chloride, and triethylene glycol solutions.